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MIL-STD-1660 TESTS ON 81MM MORTAR PALLET WITH ADAPTERS

Prepared for:
U.S. Army Armament Research,
Development and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000

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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to conduct tests on the 81mm mortar pallet with adapters. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As fabricated, the 81mm mortar pallet with adapters passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads; however, First Article Testing (FAT) is required.

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VALIDATION ENGINEERING DIVISION
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1992 MAY

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to test the 81mm mortar pallet with adapters for safety during transportation.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of these tests was to assess the capability of the 81mm mortar metal pallet adapters to meet U.S. Army (USA) functional and operational requirements for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

D. CONCLUSION. Although there was substantial movement of some of the containers within the pallet, no functional damage occurred and the 81mm mortar on 40- by 44- inch metal pallet with adapters passed the requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

E. RECOMMENDATION. The dimensions of the pallet adapters should be adjusted to account for the gaps discussed in the test results so the movement of the containers will be more restricted. There should also be more clearance between the lifting bar and the top pallet adapter to accommodate the hooks on the four-legged sling, for top lifting.

PART 2

7-22 MAY 1992

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. The four tests that were conducted on the test specimen are synopsized below.

A. SUPERIMPOSED LOAD TEST. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour, as specified in Method 5016, Federal Standard 101. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is multiplied by 192 minus the unit height in inches, divided by the unit height in inches, then multiplied by a safety factor of two. The resulting number is the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted IAW Method 5019, Federal Standard 101. The procedure for the repetitive shock test is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves 1 ± 0.1G. Midway into the testing period, the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours when the specimen is tested

in one position. When the specimen is tested in more than one position, the total time shall be three hours.

C. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation:

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
POUNDS	INCHES	INCHES
600	72	36
3,000	no limit	24
no limit	no limit	12

D. INCLINE-IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the

impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet-per-second.

PART 4

TEST EQUIPMENT

A. TEST PALLET.

1. Drawing Number:	ACV00053
2. Unitization:	3 long x 7 wide x 1 high
3. Width:	40-3/4 inches
4. Length:	44-3/4 inches
5. Height:	35-7/8 inches
6. Weight:	1,618 pounds

B. COMPRESSION TESTER.

1. Manufacturer:	Ormond Manufacturing
2. Platform:	60 inches by 60 inches
3. Compression Limit:	50,000 pounds
4. Tension Limit:	50,000 pounds

C. TRANSPORTATION SIMULATOR.

1. Manufacturer:	Gaynes Laboratory
2. Capacity:	4,000-pound pallet
3. Displacement:	1/2-inch Amplitude
4. Speed:	25 to 400 rpm
5. Platform:	5 foot by 8 foot

D. INCLINED RAMP.

1. Manufacturer:	Conbur Incline
2. Type:	Impact Tester
3. Grade:	10 percent Incline
4. Length:	12-foot Incline

PART 5

TEST RESULTS

A. SUPERIMPOSED LOAD TEST. Three pallets were load tested with no problems encountered. All pallets were tested with a safety factor ranging from 1.18 to 2.10 of the maximum expected load weight for 16 feet or 8.875 pounds. Test weights ranged form 10,500 - 18,600 pounds with all pallets passing this test.

B. REPETITIVE SHOCK TEST. Each test pallet successfully passed both the longitudinal and lateral transportation simulations. The duration of the test was 90 minutes in each orientation.

1. Test pallet no. 1 was operated at 185 and 195 rpm in order to achieve the required clearance between the pallet and the bed of the vibration table.
2. Test pallet no. 2 was operated at 220 and 240 rpm in order to achieve the required clearance.
3. Test pallet no. 3 was operated at 225 rpm its first orientation. After 50 minutes in this orientation, one of the steel bands broke due to repeated contact with the horizontal restraint bar on the vibration table. The pallet was then rebanded and testing continued; however, after a total of 86 minutes in this orientation, the band again was sheared off with the same cause of failure as the first time. The pallet was then rebanded again and turned 90 degrees where it operated for 94 minutes at 225 rpm without incident.

NOTE: Although problems were encountered with the steel bands on test pallet no. 3, the shearing of the banding was not due to the pallet adapter design. Also, it should be noted that during the testing of all three pallets, there was substantial movement of all containers except the two outside rows. The design of the top pallet adapter places almost all of its weight on the outside two rows of containers (see appendix, drawing no. 1).

C. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam 4-1/2 inches above the floor while the other side was raised to a height of 24 inches and then dropped. This process was repeated until all four sides had been tested. There was slight deformation to the pallet skids after the testing, which is to be expected. All three pallets passed the test and experienced the same slight deformations. During testing of the first pallet, it was also noted that one of the 81mm container latches became disengaged with the container still functional and serviceable after testing.

D. INCLINE-IMPACT TEST. The speed of each pallet at the instant of impact was calibrated to be 7 feet-per-second. Each pallet was impacted on all four sides at this speed, and after each test, there was no apparent damage to the pallet adapters. After the first pallet was tested, a gap of 2-1/2 inches was noted between the bottom pallet adapter and the bottom of the containers. The second pallet experienced a gap of 1-1/4 inches between the bottom pallet adapter and the bottom of the containers. There was also a 3/8-inch gap between the top pallet adapter and the top of the containers. After testing the third pallet, a gap of 1-1/2 inches was noted between the bottom pallet adapter and the bottom of the containers. The gap between this top pallet adapter and top of the containers was measured to be 3/8-inch.

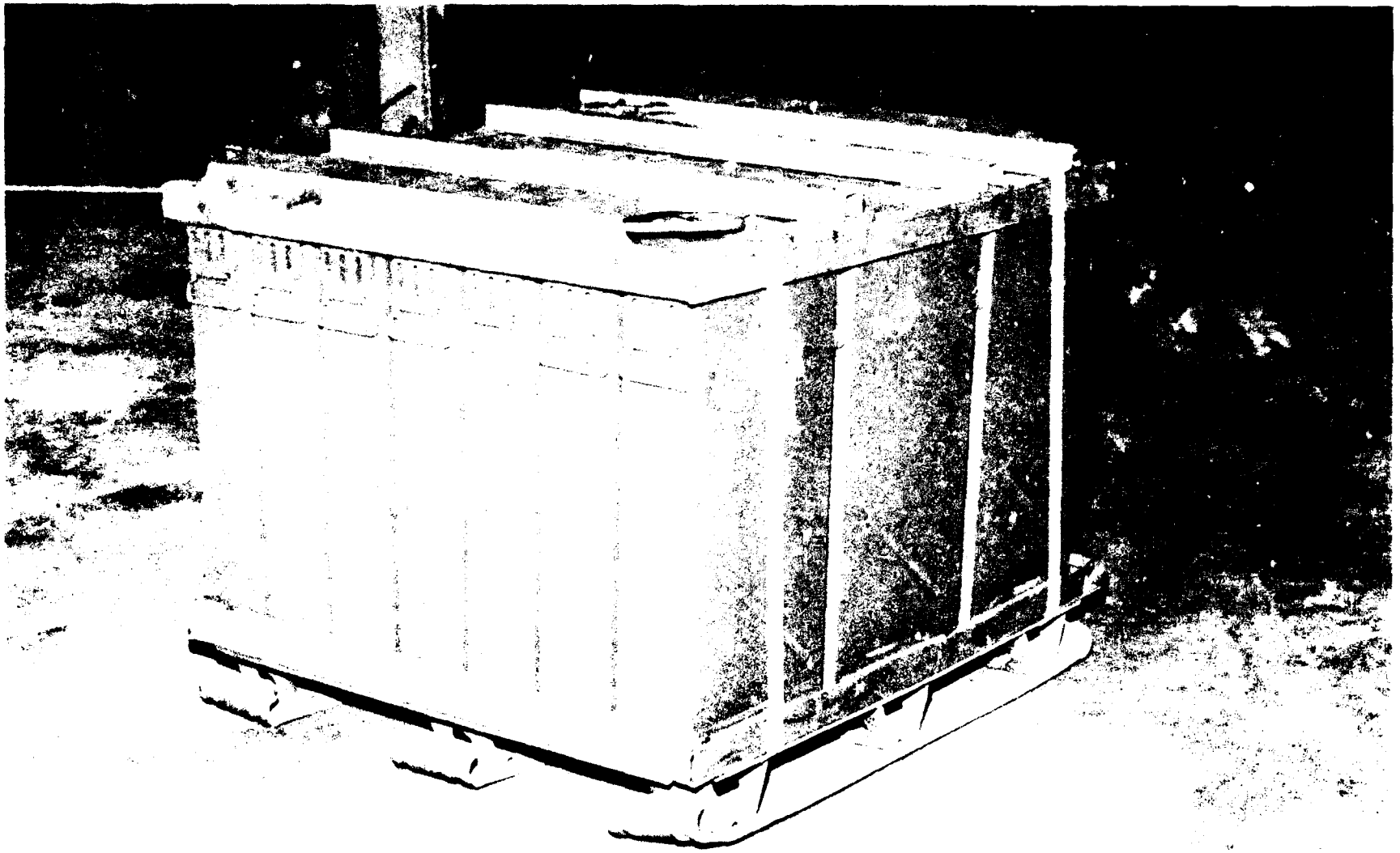
E. MECHANICAL HANDLING TEST. Three pallets were tested during this series of tests with all pallets showing the same deficiency of insufficient clearance between the top pallet adapter and lifting bar. This deficiency resulted in difficulty in sling hook engagement on to the lifting bar. Also noted during this test was some permanent deformation to the safety latch of the hook on the four-legged sling during all single sling lifts, with no damage noted to the pallet.

F. END OF TEST INSPECTION. During the final inspection of the pallets, it was evident that there was increasing damage to the spacers located on the containers. After the first test pallet was inspected, slight deformation of the pallet spacers was noted. The second series of tests

used the same containers with the final inspection showing increased deformation of the spacers. Finally, after the third iteration of tests, the spacers were completely worn through. There was no functional damage noted to the container after the third iteration. All container latches and seals were still functional. The damage to these spacers occurred during the repetitive shock test and incline-plane test.

PART 6

PHOTOGRAPHS



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-92-272-2289. This photo shows an overall view of the 81mm mortar pallet with adapters after testing.		

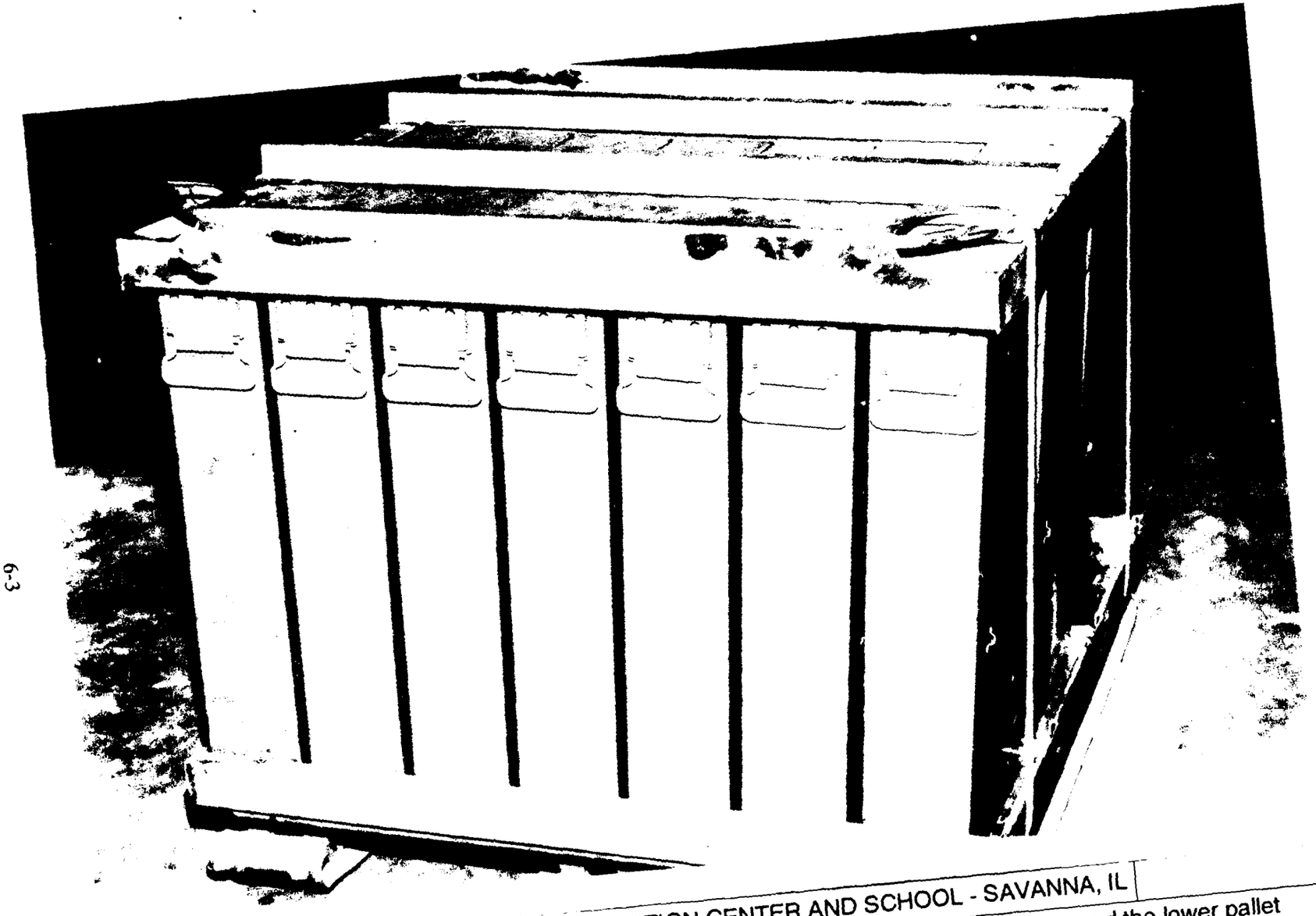


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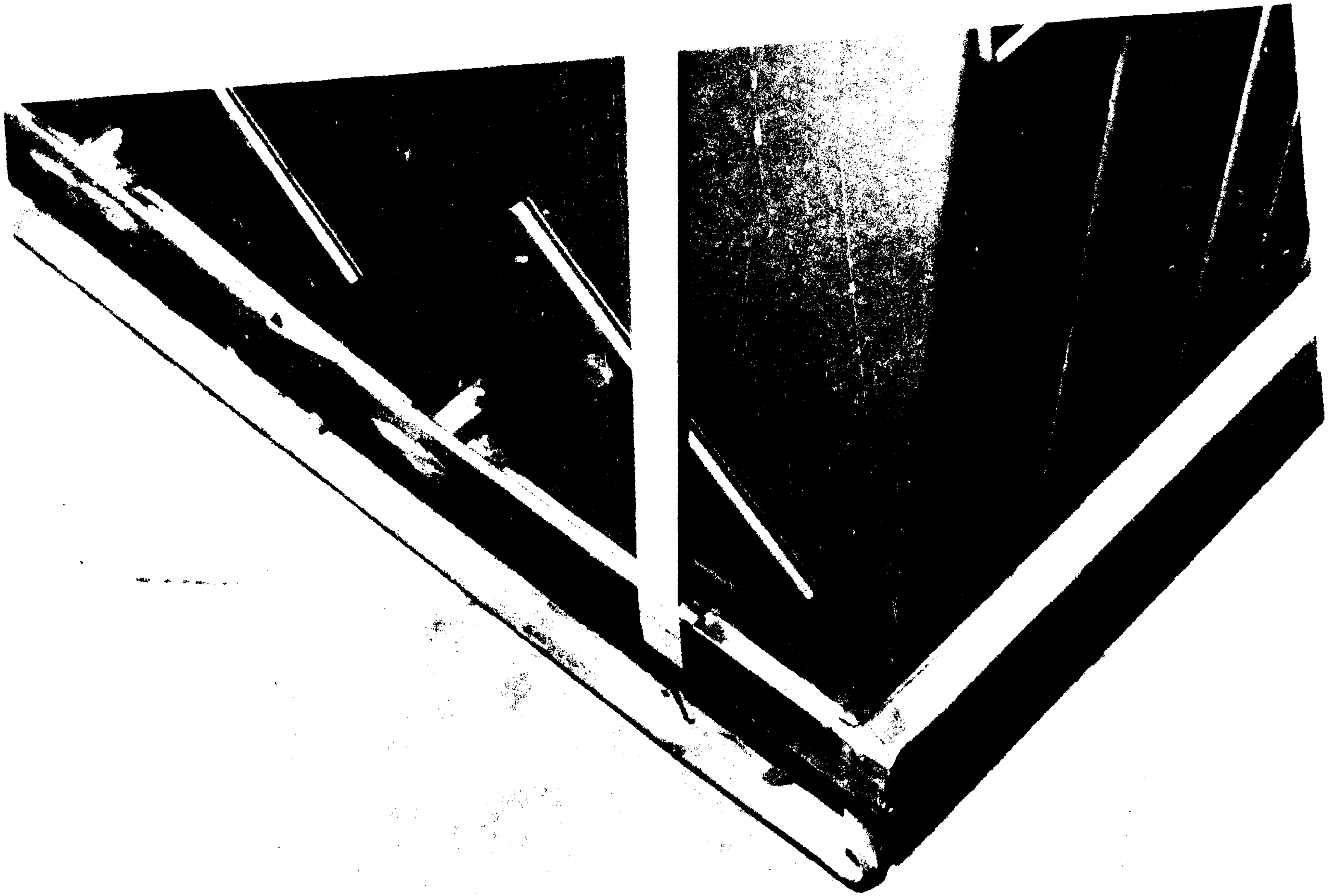
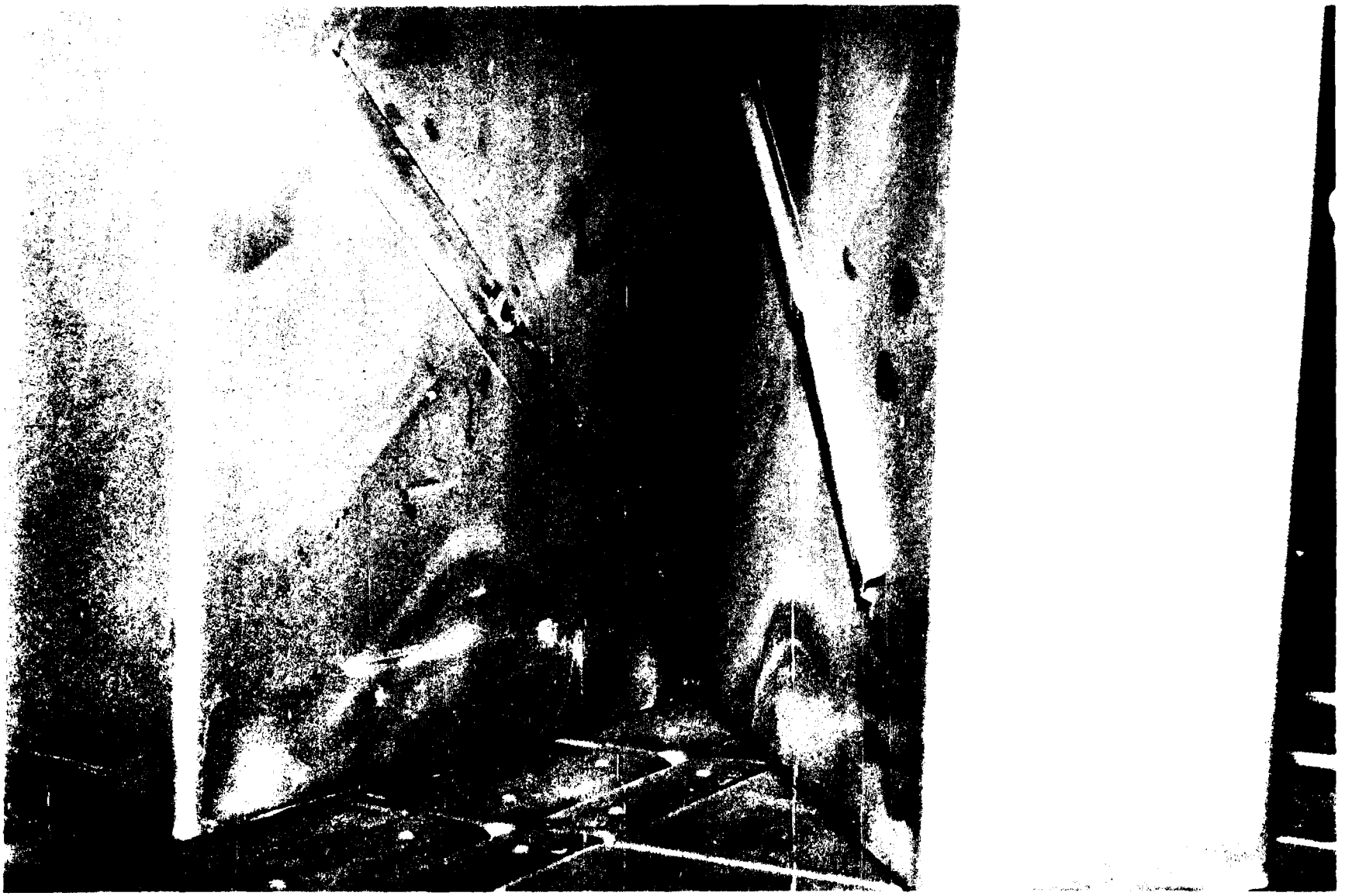
Photo No. AO317-SPN-92-2721. This photo shows the gap created between the containers and the lower pallet adapters after the incline-plane test. Note: Lower right hand corner of photo.



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-92-272-2292. This photo shows that the cutouts on the bottom pallet adapter are not necessary as the container spacers are high enough that they clear the rim of the adapter. Note: Permanent deformation to lower adapter cutout due to materiel handling equipment (MHE).		



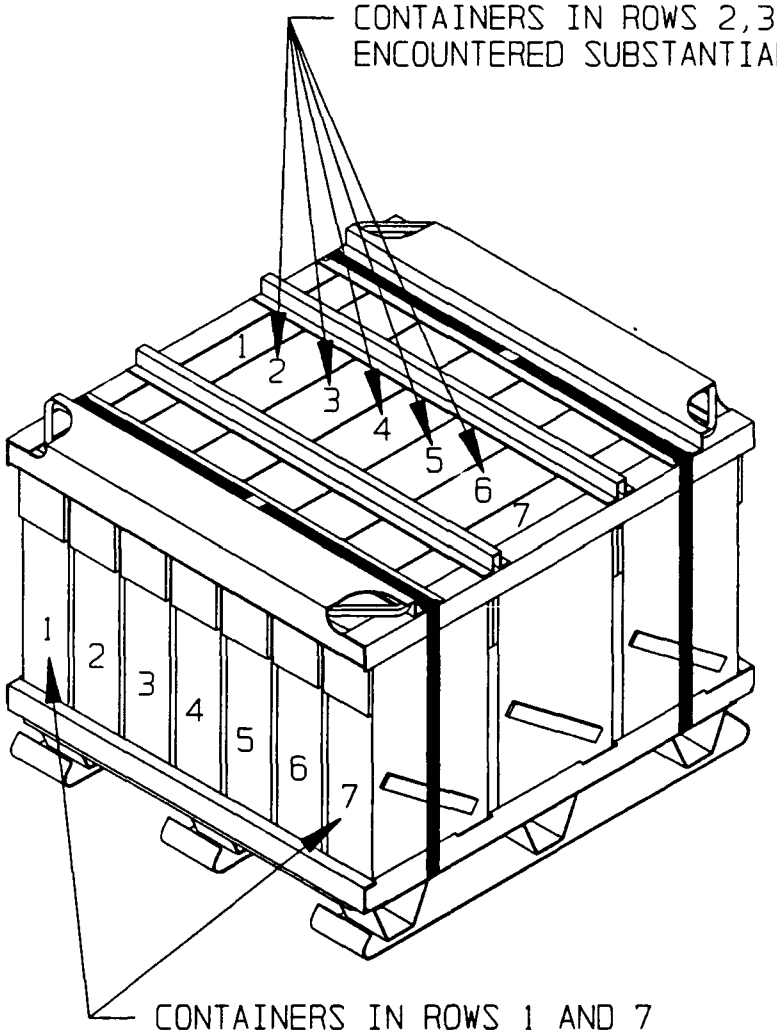
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-92-2732. This photo shows interfacing of the containers with spacers forming a cross with small areas of physical contact at the center resulting in severe damage to the spacers.		

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-JPN-92-2730. This photo shows a closeup view of container spacer damage noted in photo no. 4.		

PART 7

APPENDIX

MIL-STD-1660 TEST ON 81MM MORTAR PALLET



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